Semantics-Based Virtual Product Models: Unifying Knowledge and Product Data

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In this paper, we present a conceptual framework for how various semantics-based technologies can be used to enhance the development and use of Virtual Product Models. We start with a short introduction to semantics-based technologies focusing on ontologies, and the strongly related areas of knowledge representation, and automated inference. We present some common high-level uses for ontologies, and note two that are most promising for application to virtual product models. First, ontologies can be used for organizing, classifying and understanding product design information, at a higher level of abstraction than is commonly used today. One important goal is the formulation of precise and disciplined approach to capturing a virtual product representation for a complex product like the space shuttle, or a commercial jet liner. Towards this end, we will highlight some key distinctions that can be used to differentiate between the many kinds of information that are variously and ambiguously referred to using terms such as: 'knowledge', 'information', 'data', 'product design representation,' etc. At a more detailed level, we argue that while geometry is a critical indexing and descriptive aspect of design, it is but a fraction of the overall design concepts that should be captured.

Ontologies may be used directly as a structuring device for the many kinds of information, and also as a sophisticated indexing mechanism into product structures, which offers the promise of capturing important information at a higher level of abstraction that will be more stable and maintainable than detailed product models and data. Higher-level product designs, or architectures, can be specified independently from the details of how any particular configuration is built. Different implementations of the architecture can be created with various component modules being used in a plug and play fashion. We outline one such high level representation for capturing product assemblies, and use it as a basis for describing and comparing structuring ontologies and indexing ontologies.

A second major use of ontologies for virtual product models is to facilitate interoperability. There are many different high-level views of representing product information, as well as many different low-level formats. It will always be necessary to translate between these different formats and representations. While it is safe to assume there will not be global ontologies and formats agreed by one and all, it is nevertheless possible to create ontology to be used as a neutral interchange format for translating among various formats. This avoids the need to create and maintain O(N**2) translators. It also makes it very easy for new systems and formats to interoperate with many others.